MATERIALS BUREAU

TECHNICAL REPORT 88-3

GRANITE CURB PRODUCTION AND EVALUATION

MARCH, 1988

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NEW YORK STATE DEPARTMENT OF TRANSPORTATION
MARIO M. CUOMO, Governor
FRANKLIN E. WHITE, Commissioner

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March 1988

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ABSTRACT

Granite, as the term is used commercially, is an igneous or metamorphic rock composed mainly of quartz and feldspar. Structural granite suitable for either architectural or engineering uses may be used to make curbstone. Granite is quarried as blocks that are "burned", "wedged", "presplit", or sawed to free them from the rock mass. Quarrying methods are designed to take advantage of the principal splitting planes inherent in the granite. The orientation of these splitting planes are important, also, when the quarry blocks are sawed and split to size. The granite that is made into curbstone often contains color or textural variations that exclude it from monumental or architectural use.

New York receives granite curbstone from as far away as Georgia yet it is priced competitively with the New England granites. This is due to by the wide variation in cost factors such as labor, freight and the workability of different granites.

NYSDOT Standard Specifications require each quarry from which curbstone originates, to appear on the Approved List. There are no physical tests required, only a visual inspection for structural defects and staining minerals. Each approved quarry has been subjected to geologic evaluation by the Materials Bureau Geology Unit.

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TABLE OF CONTENTS

		Page
ABSTRACT		ii
ACKNOWLEDGEMENTS		iii
I. SCOPE		1
II. RESULTS AND DISCUSSION		1
	Granite	1
	Quarrying Granite for Curbstone	1
	From Blocks to Curbs	3
	The Granite Industry	4
	Testing and Evaluation of Granite Curbstone	4
III. CONCLUSIONS		5
APPENDICES		6
A	Glossary of Terms	7
B	NYSDOT Standard Specifications	10
	714-01, Stone Curb	11
	712-07, Right-of-Way Markers	13
C	ASTM Standard Specification	14
	Granite Building Stone (C615-85) - Abstract	
D	ASTM Standard Test Methods	15
	Absorption and Bulk Specific Gravity of Natural Building Stone (C97-83) - Abstract	16
	Compressive Strength of Natural Building Stone (C170-85) - Abstract	17
	Modulus of Rupture of Natural Building Stone (C99-85) - Abstract	18

GRANITE CURB PRODUCTION AND EVALUATION

I. SCOPE

This report briefly outlines the granite curbstone industry that normally serves New York State, and the evaluation of its product. Included is a discussion of the geology and occurrence of the granite bodies, methods of quarrying, production of granite curb, and the test methods used to determine its quality.

II. RESULTS AND DISCUSSION

Granite

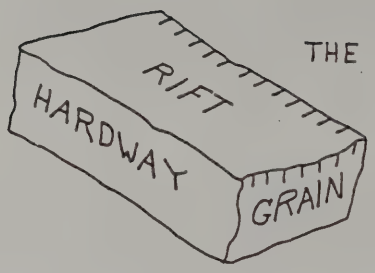
The industry's use of the term "granite" is broader than that of the geologist. The term includes true granite, granite gneiss, syenite, quartz monzonite, granodiorite, diorite, gabbro, diabase, and anorthosite. "Granite" is an igneous or metamorphic rock consisting mainly of the minerals feldspar and quartz along with various accessory minerals. The texture of granite is one of interlocking crystals of generally uniform size. The characteristics most important to the granite industry are those of color, texture, and uniformity. Of greatest concern are seams and cracks that would impair structural integrity and the presence of minerals that weather to create stains.

Structural granite is divided into two general use classifications: architectural including monuments, and engineering including curbstone. Industry standards for architectural granite are higher than those for granite for engineering applications. The basis for the separation is aesthetic rather than structural. Small variations in color or texture, or the presence of seams, is enough to exclude the stone from architectural use.

Granite occurs as masses or bodies that may be up to several miles in length. Depending on the type, the granite might appear quite homogeneous or may be banded or have a contorted appearance. There may or may not be a sheet structure in the rock body that separates the granite into sheets or beds. It is believed that this sheeted structure is related to the release of deepseated stresses within the rock mass. The sheets are typically parallel to the ground surface and increase in thickness with depth. Sheeting, when it occurs, is an important factor in quarrying granite.

Quarrying Granite for Curbstone

For the quarryman, the most important features of the granite body are the directions of the principal splitting planes. The orientation of the plane along which splitting most easily occurs is universally known as the "rift". The orientation of the plane least easily split is variously known as the "head", the headgrain", or the "hardway". The plane intermediate in splitting ease is known as the "grain", the "run", or the "lift". Each plane is roughly perpendicular to each other. It is not fully understood what determines the orientation of these planes, but some think it arises from parallel microcracks within the granite body. Investigations have shown that foliation, banding, streaking, flow structures, or seam orientation gives no clue to the orientation of these splitting planes.



THE PRINCIPAL SPLITTING PLANES

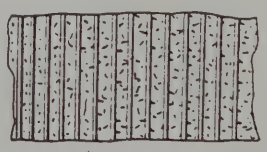
Our investigations has also shown that the orientation of these planes varies from quarry to quarry, but are in the same general orientation within a granite body. For instance, the Elberton (Georgia) Granite has a rift that is roughly horizontal although it is not precisely the same from quarry to quarry. In contrast, the Barre (Vermont) Granite has a rift that is nearly vertical.

The granite quarryman may use various techniques to divide the stone into the roughly rectangular blocks he sends to the cutter. The usual methods are burning, wedging, presplitting, and sawing.

Burning (Jet Piercing) - a long torch is applied to the rock and the rapid expansion at the site of burning causes the rock fly apart. The force of the escaping gases blows the chips out of the channel thus formed. The torch uses fuel oil mixed with air or oxygen and burns at a temperature of about 2000°F to about 2800°F. The burned channel is about 4" wide and may be as long and as deep as required.

Wedging - short holes, perhaps 6" to 10" long and 3/4" to 1" in diameter, are drilled in a line spaced perhaps 6" apart. Three-part iron or wooden wedges are driven into the holes. Gradually the wedges are driven deeper until cracks develop between the holes and eventually through the granite mass.

WEDGED FACE



PRESPLIT FACE

Presplitting - closely spaced holes are drilled to the full depth of stone mass required to be split. Low explosive charges or primachord are set off in the holes simultaneously, splitting the rock between holes.

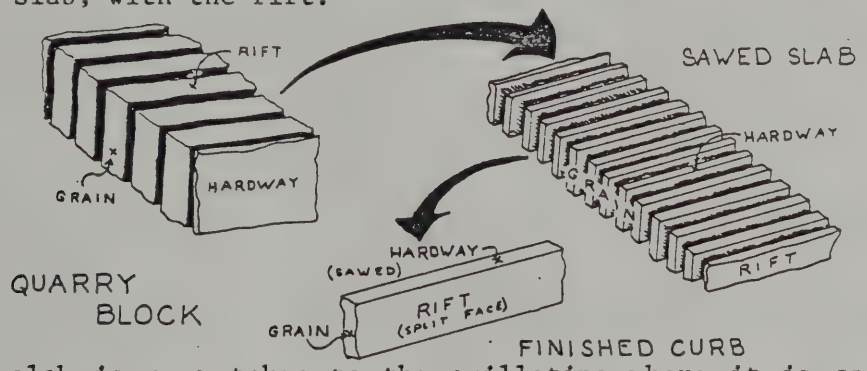
Sawing - a portable wire saw assembly is set up on a stone block already free on 4 sides. An abrasive slurry clinging to the twisted wire is drawn across the stone, cutting a thin channel about 1/4" wide. Where this method is used, a gang of six saws are sawing slabs simultaneously.

Block cuts along the headgrain are usually burned, sometimes presplit, and occasionally sawed or wedged. Rift or grain splitting is generally accomplished by wedging. Horizontal splits are often facilitated by small explosive charges. The method used for a given cut is determined by the situation within the quarry. Every quarry we visited employed burning and all used explosives to some extent. Wedging is also a universally used method. Sawing is employed at only a few quarries. Where possible natural parting planes are intersected and the usual horizontal splitting can be avoided.

Once the blocks are freed from the granite mass they have to be removed from the quarry. Most operators use stationary derricks or movable cranes. Occasionally, 20 ton fork lifts are used. The measurements of the blocks range from about 8 to 15 feet on the long dimension and from 3 to 5 feet on the short dimension. These blocks generally weigh between 10 and 20 tons.

From Blocks to Curbs

The quarry block is next taken to the stone cutters. In most cases the block is placed on a pallet that moves on a track perpendicular to the saw blade. The saw may be a wire saw but is usually a large diameter circular saw with diamonds. Proper orientation of the stone block, with respect to rift, grain and hardway, is essential. Blocks are marked in the quarry to indicate these directions. Architectural stone is sawed parallel to the rift plane so that the slab will be most resistant to breakage across the slab. Curbstone is sawed parallel to the hardway so it will split most easily across the slab, with the rift.



The sawed slab is next taken to the guillotine where it is split into curbstone. Since the sawed faces are parallel to the hardway, the slab will be split along the rift producing a curb with a sawed top and base and evenly split faces.

The guillotine is a machine having two horizontal opposing blades about 6 feet long. The blades are placed in contact with the sawed faces of the slab and the force applied to the blades splits the slab.

Curved or radius curbstone is generally made by wedging a curved split, guillotining a curved split, or guillotining a wide straight split and dressing it into the proper curve.

Hand dressing curb is always required to some extent. Granite having a well developed rift and a finely crystalline texture requires the least dressing. Curved curb requires a great deal of handwork. Most hand dressing is done with a hammer and chisel. Some special dressing machines are use to produce particular surface finishes but are not widely employed for curb work.

The Granite Industry

Curbstone production is generally given a subordinate position within the Granite Industry. Monument and architectural dimension stone production demands the premium product. Engineering applications, including curbstone, have less stringent requirements (Classification shown in ASTM C615-85). The distinction between the two is basically aesthetic rather than structural. A granite free of variation in color and texture and without structural flaws is suitable for architectural uses. Engineering granite must also be free of structural flows but may include granite having some variation in color and texture such as colored seams, "shadows", bands and knots. In many cases, granite blocks that are not "clear" of color and texture variations, that is, of a grade suitable for engineering purposes, are simply discarded by the monument producers. The fabricator of curbstone may, however, use granite of both suitable for architectural and engineering use, and has, in some cases, availed himself of blocks formerly wasted by the monument stone quarry man. The reduced cost at which the ordinarily discarded blocks can be obtained by the curbstone manufacturer is one factor that enables him to compete in more distant markets.

It is important to explain why curbstone fabricated from granite quarried as far away as Georgia can compete with the New England granites for the New York State market. In spite of some claims that one granite is better than another. it is the price of delivered curbstone that is the major factor in the competition between suppliers. In addition to the obvious cost of freight, labor is an important component of the price from the standpoint of both quarrying and fabrication. Additional labor costs arise from increased handling of material in both the quarrying and the fabrication process. The more rectangular the quarry blocks are, the less waste rock that must be handled both in the quarry and in the cutting plant. The more handwork required in dressing curbstone, the greater the cost. Apparent inefficiencies, however, are often not the fault of the operator but are due, rather, to the nature of the stone. A granite of acceptable quality in terms of strength, uniformity, and appearance may present difficulties in quarrying and cutting that add cost. Granites that have poorly developed splitting planes and coarsely crystalline textures simply require more labor and generate more waste than many finer crystalline, easier splitting granites.

Testing and Evaluation of Granite Curbstone

The granite industry generally relies on the ASTM Standard Specification for Structural Granite (C615)* in evaluating their product. The Specification includes four physical tests**: Absorption by Weight, Density, Compressive-Strength, and Modulus of Rupture, as well as a visual inspection for structural flaws and staining minerals. The specification applies to all use classifications, whether architectural or engineering.

*The ASTM Standard Specification abstract included in Appendix C.
**The applicable ASTM Standard Test Methods abstracts are included in Appendix D.

NYSDOT Standard Specifications, as they apply to stone curb and right-of-way markers[+], require a visual inspection for structural defects and staining minerals. In addition, the quarry from which the granite originated must appear on the Approved List published under 7.42-3.1-2 Materials by Manufacturer or Supplier [14] Dimension Stone: Stone Curb and Right-of-Way Markers.

The NYSDOT has not incorporated any physical tests into the requirements for granite curbs or right-of-way markers. Field performance of many different granites has shown them to perform equally well. Geologic evaluation of each approved quarry by the Materials Bureau Geology Unit and a discussion of potential problems with each quarry operator, has assured a satisfactory product. Variations in color or texture, including most seams, do not impair the structural integrity of the granite. Cracks and seams of weakness are readily recognizable and are nearly always brought to failure in the fabrication process. The imposition of physical tests would not enhance the evaluation of these granite items.

III. CONCLUSIONS

Each granite quarry that appears on the Approved List has been evaluated by the Materials Bureau Geology Unit. Each can supply a uniform and consistent product meeting our requirements. Field performance of many different granites has shown them to perform equally well. Variations in color and texture, including most seams, do not impair the structural integrity of the granite. Cracks and seams of weakness are readily recognizable and are nearly always brought to failure in the fabrication process. The imposition of physical tests would not enhance the evaluation of these items.

[+]The NYSDOT Standard Specifications are included in the Appendix B.

APPENDICES

APPENDIX A

GLOSSARY OF TERMS

Bedding Planes - the parting planes that occur within a sheeted granite body. The parting planes are roughly parallel the ground topography and are most closely spaced near the surface.

Blocks - the rectangular granite units that are removed from the quarry. Blocks generally weigh between 10 and 20 tons.

Boulder Granite - a granite body having no sheet structure and hence no "bedding" planes.

Building Stone; natural-rock material in its natural state of composition and aggregation as it exists in the quarry and is usable in construction as dimension stone (ASTM).

Burning - a technique used in quarrying dimension stone where a jet-like torch is used to cut a narrow trench about 4 inches wide (also jet piercing).

Crane - a boom on a movable base. In the dimension stone industry it is used for lifting blocks from the quarry (see derrick).

Derrick - a boom on a stationary base. The derrick consists of an upright member, held in place by guy wires, and a boom, that pivots at the base of the upright. The boom is raised and lowered by cables from the upright member. Its function is similar to that of the crane.

Dike - A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks (AGI). Occasional dikes of very dark rock are seen in granite quarries. The dikes must be avoided.

Dimension Stone - natural building stone that has been selected, trimmed, or cut to specified or indicated shapes or sizes, with or without one or more mechanically dressed surfaces (ASTM). The term dimension stone is in contradiction to crushed or broken stone.

Dressing - the process by which split stone is further worked to conform with specified dimensions. This process may involve hand tools, such as hammer and chisel, or machines.

Flamed Surface - A torch in applied to a sawed face to produce a finish that is moderately irregular yet not rough.

Gang Saw - a rock saw having multiple blades (as many as 100) working back and forth to saw many slabs at once.

Grain - see "Splitting Planes".

Granite - a visibly granular, crystalline rock of predominantly interlocking texture, composed essentially of alkalic feldspars and quartz. Accessory minerals, such as micas, hornblende, or more rarely pyroxene, are commonly present. "Commercial Granite" includes certain established species of rocks, similar in texture and closely related in composition, known as gneiss, gneissic granite, granite gneiss, granodiorite, syenite, monzonite and anorthosite. "Black granite" includes diabase, diorite, and gabbro (ASTM).

Guillotine - a machine used for splitting dimension stone precisely. A sawed slab is placed between the two horizontal opposing blades. A great force is applied to the blades, splitting the stone.

Hardway - see "Splitting Planes".

Head - see "Splitting Planes".

Jet Piercing - see "Burning".

Joint - a fracture or parting which interrupts abruptly the physical continuity of the rock mass (AGI). For sheeted granite bodies, joints are distinguished from "bedding" planes.

Key Cut - The initial unit of stone removed in a quarry or lift within a quarry. Generally the key is cut by burning on four sides. Then, one or more holes are drilled to the depth of the lift and explosive charges are set off at the bottom of each hole. The rock mass splits roughly horizontally until the burned trenches are intersected and the rock unit is freed.

Knot - a term used to describe a small localized concentration of accessory minerals usually appearing darker than the surrounding rock. A knot is not be confused with an inclusion of a foreign rock material.

Layered Granite - see "Sheet Granite".

Lift - each level within a quarry. The term bench is also applied. In sheet granites the "bedding" planes may be called "lift joints". (See also "Splitting Planes".)

Pavers - paving blocks - rough split rectangular blocks measuring about 9 to 12 inches in the long dimension and 3 to 6 inches on the small dimensions.

Presplitting - the process of splitting rock by drilling a line of closely spaced, full-depth holes and setting off explosive charges within these holes.

Radius - a curved section of curbstone. A 30 foot radius curbstone is one having the curvature of a 30 foot radius circle.

Rift - See "Splitting Planes".

Rotary Saw - a circular, diamond impregnated saw having a diameter of up to 11 feet used for cutting thick slabs of stone. The spinning blade travels back and forth through the cut moving lower with each pass. Most granite curb producers slab their blocks using rotary saws.

Sap Rock - weathered, disintegrating rock found at the surface or along open joints. Depth of weathering in granite is usually measured in inches.

Seams - long, well-defined zones where the color, texture and mineralogy are different from the surrounding rock. Because of their linear nature one is inclined to see them as structural defects. Our investigations have borne out the quarryman's claim that there is no preferential breaking along these seams and that they represent no loss in structural integrity. There are linear features that are structurally weak and these are well known to the quarryman. These features have various names (black lines, slicks, etc.) and are avoided.

Shadows - linear variations in color and/or texture. They are not well-defined like a seam but are similar to a knot. Shadows show best on a wetted or polished surface.

Sheet Granite - the sheet structure is the separation of the granite mass into sheets or "beds" by fractures parallel to the bedrock surface. These fractures are also known as parting, bedding, or lift planes. The phenomenon is not universal but where it does occur, the fracture planes are incorporated into the quarry process. The fracture planes tend to get more widely spaced, flatter, and more regular with depth.

Slabs - pieces sawed from blocks. In curbstone manufacture, slabs are sawed parallel to the "hardway" as thick as the curb is deep. The curb is then split or guillotined from the slab laid on its sawed face.

Splitting Planes - granite quarries are oriented to take advantage of certain preferred splitting planes. These splitting planes are roughly at right angles to one another and allow even sided rectangular blocks to be quarried. Curved or irregularly sided blocks indicate the splitting was not properly oriented or the splitting plane is not well developed.

The "rift" is a term universally used for the easiest splitting direction.

The next easiest splitting direction is the "grain", the "run" or, when it occurs as a horizontal plane, the "lift". The plane along which splitting is resisted is called the "head", the "head grain", or the "hardway".

Veins - rock fractures filled with minerals.

Weathering - rock deterioration caused by exposure to weathering agents such as water, frost, wind, vegetation, and naturally occurring chemical agents.

Webs - when closely spaced holes are drilled in rock for wedging or presplitting, the rock bridges between the holes are called webs.

Wedging - short holes are drilled in a line spaced about 6 inches apart. Wedges are driven into the holes to split the rock along the line. Wedging is used to quarry blocks and, in some cases, to make radius curbs.

Wire Saw - a loop of two strand twisted wire that is drawn through a stone block. The wire carries a slurry of emery and water that does the cutting. Traditionally, the loops are very large and extend to wheels outside the cutting shed.

APPENDIX B

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

STANDARD SPECIFICATIONS

714-01 Stone Curb

712-07 Right-of-Way Markers

714-01 STONE CURB

SCOPE. This specification covers the material and fabrication requirements for stone curb used in highway and bridge construction.

MATERIAL REQUIREMENTS. Stone curb shall be either a bluestone, sandstone or granite. The stone shall be sound and durable, free from seams which impair its structural integrity and of a smooth splitting and machining character. Natural color variations that are characteristic of the deposit will be permitted. Any curb containing discoloration other than cleanable surface stains shall be sampled and submitted to the Materials Bureau for evaluation.

Dimensional Requirements.

1. General. Curb shall be cut to conform to the shape and size shown on the standard sheets and contract plans.

2. Curbs on Straight Sections. Minimum lengths of straight segments of economy and sloped curbs shall be two feet. All other straight curb types shall have three feet minimum lengths.

3. Curbs on Curved Sections. No minimum length requirements are specified for curb segments on curves with radii of 200 feet or less. When directed by the Engineer, curb segments on curves with radii 101 to 200 feet shall be cut in 3 to 4 feet straight lengths. With exception of Economy and Sloped curbs, segments on curves with radii of 100 feet or less shall be shaped to the required curvature and the ends cut on radial lines. Economy and Sloped curbs shall be furnished only in straight segments and on curves with radii less than 10 feet, their ends shall be cut on radial lines.

4. Transition Curb for Bridge to Roadway Curbs. A transition curb for bridge curb to roadway curb shall be furnished, if required. Where an 8-inch exposed face is desired for a roadway curb, the appropriate curb sections with a 6-inch exposed face shown on the appropriate section of the standard sheet shall be increased 2 inches in depth.

5. Curb Widths. The bottom width of the various types of curbing shall be as follows:

Type	Width
A,B,C,D,E,T_2 and Economy	4 inch minimum for 2/3 of length
F_1,G_1,M and T_1	4 inch minimum for entire length
R_1 and R_2	8 inch for entire length
S	5 inch for entire length

Finish.

1. General. Curb surfaces shall be finished as indicated on the plans or standard sheets.

2. Top Surfaces. Top surfaces shall be finished to approximately true planes. When sawed, hammered or thermal finishes are applied, no projection or depression shall be greater than 3/16". Saw marks normal to the sawing process will be permitted if within the 3/16" tolerance.

3. Arris Lines. Top front arris lines shall be straight and true with no variations greater than 1/8 inch measured from a 2 foot straightedge placed along the arris line.

Back arris lines on curb types E,F_1,M,T_1, and T_2 curb and the lower front arris lines on types E,F_1,M,R_1,R_2,S,T_1 and T_2 curbs shall be straight and true with no variations from a straight line greater than 1/4 inch measured in the same manner. Back arris lines are not required for types R_1,R_2 and S curbs.

Exposed arris lines at the joints shall not project beyond the plane of a split face and shall not fall under the plane of a split face more than 1/4 inch.

4. Back Surfaces. Back surfaces shall have no projection or depression which exceeds a batter of 1 inch in 3 inches for a distance of 3 inches from the top.

5. Front Exposed Faces. Front exposed faces of straight Types A,F_1, and G_1 curbs, when split, shall have no projection greater than 1 inch or depression greater than 1/2 inch measured from a vertical plane passing through the arris line at the top of the split face. For radius units the front exposed faces when split, shall have no projection greater than 1-1/4". The entire face of Type G_1 curb shall be considered as exposed face. Front exposed faces of types M,R_1,R_2,S,T_1 and T_2 curbs, when split, shall have no projection or depression greater than 1/2 inch measured from a vertical plane passing through the arris line at the top of the split face. Front faces below grade shall have no projection or depression greater than 1 inch measured in the same manner.

No projection on the exposed face of type C curb shall extend over 1/4 inch beyond a vertical plane extending from the intersection of the pavement grade line and the curb face. The exposed face of type C curb shall have no depression greater than 1/2 inch measured from the plane of the face through the top arrris line.

6. Ends. Ends of curbs shall be approximately square with the planes of the exposed curb surfaces and shall be finished so that when curbs are set, no space greater than 3/4 inch shall show in the joints for the full length of the exposed joint. The curb ends below the pavement surface or shoulder shall break not over 8 inches from the joint plane on curb types A,B,C,D,E and T_2 curbs and not more than 2 inches on types G_1,R_2, and T_1.

Ends of types F_1,G_1,M,R_1,R_2,S and T_1 curbs shall be sawed at locations called for on the contract plans.

7. Drill Holes. Drill holes will not be permitted in exposed curb surfaces.

Exceptions to Finish Requirements.

1. Economy Type Curbs. Top surfaces shall be split so that no projections or depressions are greater than 1/2 inch.

Front arris lines shall not vary from a straight line more than 1/2 inch.
Exposed joint openings shall not exceed 1-1/2 inches.
Drill holes will be permitted in top and face surfaces.

2.. Sloped Type Curb. Exposed faces shall be smooth and quarry split to an approximately true plane having no projection or depression greater than 1 inch from a 2 foot straightedge placed as closely as possible to the plane of the curb face.

Drill holes not more than 3 inches long and 1/2 inch deep will be permitted in the face.

Arris lines at joints shall not project beyond the plane of the split face and shall not fall more than 1/2 inch under the plane of the split face.

Curb ends shall be approximately square with the plane of the exposed curb surfaces and finished so that when curbs are set, no space greater than 1 1/2 inches shall show in the joints for the full width of the face.

BASIS OF ACCEPTANCE.

Stone curb shall be from a source appearing on the Department's Approved List and will be accepted in accordance with procedural directives of the the Materials Bureau. In addition, the stone curbing will be inspected for dimensional compliance at the project site by the Engineer. Curbing not in compliance with the dimensions on the standard sheets or contract plans will be rejected by the Engineer.

712-07-GRANITE RIGHT-OF-WAY MARKERS

SCOPE. This specification covers the material and fabrication requirements for granite right-of way markers.

MATERIAL REQUIREMENTS. Right-of way markers shall be granite of a light color. The stone shall be sound and durable, free from seams which impair its structural integrity and of a smooth splitting and machining character.

DIMENSIONAL REQUIREMENTS. The markers shall be cut to conform to shape and size shown on the standard sheets or contract plans. The top shall have a sawn or peen-hammered finish and be pitched to form a square or rectangle. Drill holes will be permitted in the sides and bottom. A hole 1/2 inch in diameter and 1/2 inch in depth shall be drilled in the center of the top of each marker.

BASIS OF ACCEPTANCE. The granite right-of-way markers shall be from a source appearing on the Department's Approved List and will be accepted in accordance with the procedural directives of the Materials Bureau. In addition, the markers will be inspected for dimensional compliance at the project site by the Engineer. Markers not in compliance with the dimensions on the standard sheets or contract plans will be rejected by the Engineer.

APPENDIX C

STANDARD SPECIFICATION FOR GRANITE BUILDING STONE (ASTM C615-85)

Abstract

The specification covers the material characteristics, physical requirements and sampling of granite for use as building stone. This includes granite that is cut or shaped to specific dimensions. Granites are classified by intended use but all must meet or exceed specific requirements of absorption, density, compressive strength, and modulus of rupture. In addition, the granite must be free of anything that would impair its structural integrity or cause objectionable staining.

APPENDIX D

ASTM STANDARD TEST METHODS FOR:

Absorption and Bulk Specific Gravity of Natural, Building Stone (C97-83) (Abstract)

Compressive Strength of Natural Building Stone (C170-85) (Abstract)

Modulus of Rupture of Natural Building Stone (C99-85) (Abstract)

STANDARD TEST METHOD FOR ABSORPTION AND
BULK SPECIFIC GRAVITY OF NATURAL BUILDING STONE (ASTM C97-83)

Abstract

Absorption is determined on a specimen of regular shape having its least dimension not less than 2" and its greatest dimension not greater than 3". The specimen is dried for 24 hours and weighed, then immersed in water for 48 hours and weighed in a surface dry condition. The difference in these two weights, divided by the dry weight, is the absorption. The absorption is expressed in percent.

Bulk specific gravity is determined on specimens meeting the same criteria as in the absorption determination. A minimum of three specimens shall be tested. Specimens are dired for 24 hours and weighed, then immersed in water for 48 hours and weighed in a surface dry condition, finally the soaked specimens are weighed while suspended in water. The dry weight divided by the difference between the soaked surface dry weight and the weight of the soaked specimen in water, is the bulk specific gravity.

STANDARD TEST METHOD FOR COMPRESSIVE STRENGTH
OF NATURAL BUILDING STONE (ASTM C170-85)

Abstract

Test specimens may be cubes, square prisms or cylinders, cut from a representative sample by sawing or core drilling. The diameter or lateral dimension may not be less than 2", and the ratio of height to diameter (or lateral dimension) may not be less than 1:1. A minimum of five specimens shall be prepared for each condition of the test (wet, dry, orientation with respect of rift).

Each specimen is placed in a vertical loading machine, used for determining compressive strength, and brought to failure. The total load achieved before failure is divided by the area of the bearing surface to calculate the compressive strength.

STANDARD TEST METHOD FOR
MODULUS OF RUPTURE OF NATURAL BUILDING STONE (ASTM C99-85)

Abstract

Test specimens shall be approximately 4 X 8 X 2¼" sawed to size with surfaces ground smooth. A minimum of five specimens shall be prepared for each condition of loading (wet, dry, orientation with respect to the rift).

The testing machine consists of two knife-edge supports placed near the ends of the test specimen. Loading is accomplished vertically onto a knife edge located midway between the supports. The specimens are brought to failure.

The modulus of rupture is calculated by:

$$R = 3wl/2bd^2$$

WHERE: R = modulus of rupture
w = breaking load
l = length of span
b = width of specimen
d = thickness of specimen

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